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Can *Porcine circovirus type 2* (PCV2) infection be eradicated by mass vaccination?

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ABSTRACT

The feasibility to eradicate *Porcine circovirus type 2* (PCV2) in a conventional PCV2 infected farm by vaccinating both sows and piglets using a commercially subunit vaccine was assessed. Vaccination strategy implied that all sows, boars and gilts of the farm were vaccinated every four months, and all piglets vaccinated and revaccinated with the same vaccine at 4 and 7 weeks of age, respectively. This vaccination strategy was applied during 12 consecutive months. Blood samples from 15 piglets of 4, 8, 12, 16, 20 and 24 weeks of age and 15 sows were taken monthly PRE, DURING and POST mass vaccination strategy. From all the collected sera ($n = 1796$), a representative proportion of them ($n = 1235$, 69%) were analysed ($n = 1121$ from piglets and $n = 114$ from sows). All these samples were tested by PCV2 ELISA and PCV2 PCR (and quantitative-PCR when PCR positive). All tested sows were negative by PCR but seropositive. ELISA mean OD values of sows decreased throughout the study. Percentages of PCV2 PCR positive samples in piglets were 8% (12/150), 0.9% (6/659) and 3.5% (11/312) PRE, DURING and POST application of the mass vaccination program, respectively. ELISA mean OD values of PCV2 seropositive animals progressively decreased until the end of the mass vaccination period, but a clear seroconversion was observed after stopping such strategy. In conclusion, one year period of mass PCV2 vaccination (without implementing further farm management practices or biosafety measures) was not able to clear out PCV2 infection, and the virus became detectable again when vaccination was stopped.

1. Introduction

Porcine circovirus type 2 (PCV2), a circular single-strand DNA virus of the Circoviridae family, is the etiologic agent of a number of swine diseases collectively named as porcine circovirus diseases (PCVD) (Segalés, 2012). The most significant conditions included as PCVDs are the PCV2-systemic disease (PCV2-SD) (also known as postweaning multisystemic wasting syndrome [PMWS]), porcine dermatitis and nephropathy syndrome (PDNS) and PCV2-reproductive disease (Rose et al., 2012; Segalés, 2012). PCV2-SD is considered the most economically significant condition within PCVDs (Segalés et al., 2012).

Traditionally, PCV2-SD control was based on preventing risks or triggering factors by means of management improvement, control of co-infections and changes of the boar genetic background (Fraile et al., 2012a). Nowadays, the disease control is mainly based on vaccination. The vaccines currently available in the international market have shown to be very effective in controlling PCV2 infection and PCV2-SD under both

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experimental and field conditions (Cline et al., 2008; Opriessnig et al., 2010; Fachinger et al., 2008). Such vaccines are able to improve production parameters (mortality and average daily gain) and reduce viraemia, viral shedding, PCV2-SD associated microscopic lesions and the likelihood of co-infection with other viruses (Fort et al., 2008; Fraile et al., 2012b; Gerber et al., 2011; Kixmoller et al., 2008; Martelli et al., 2011; Pejsak et al., 2010; Segalés et al., 2009).

Viral load reduction and lower percentage of infected pigs are perceived as corner-stones in order to control the clinical outcome of the infection. In such respect, results of several PCV2 experimental studies have shown a complete elimination or clearance of PCV2 infection by using two (Fort et al., 2008) and one doses of different PCV2 commercial vaccines (Hemann et al., 2012; O'Neill et al., 2011). These results opened the question whether the use of vaccination may be an efficient way to eventually eliminate or eradicate PCV2 infection. Considering that with the normal vaccination strategy (one dose for most of the commercial vaccines), PCV2 infectious pressure is reduced (Fort et al., 2009; Opriessnig et al., 2009), one might speculate that a more extensive vaccination program could be used to potentially eradicate the infection.

In the worldwide pig production, there are some examples of pathogen eradication programs based on the combination of vaccination and management strategies. Among them, the eradication program of Aujeszky's disease virus (ADV) is one of the most successfully and extended programs. Its strategy is mainly based on a mass vaccination program (vaccination of the entire population) combined with animal movement restrictions. In Spain, ADV eradication program included compulsory vaccination of breeding sows (at least three times per year done in a blanket fashion), fatteners (at least two times separated by 3–4 weeks) and gilts (three times before entering the reproductive cycle) (Allepuz et al., 2009). Such intense efforts to control this disease concluded with the classification of Spain in 2011 as an ADV officially free country (Vicente-Rubiano et al., 2012).

In the present study, the feasibility to eradicate PCV2 infection in a conventional farm by vaccinating both sows and piglets in a 12 consecutive month period was explored. Besides, the humoral immunological response after vaccination of sows and piglets in different batches of the same farm was monitored.

2. Materials and methods

2.1. Farm selection

The present study was conducted in a 390-sow, two-site Spanish farm without previous history of PCVD. Site one was composed by breeding, lactating and nurseries units. Site two was located 40.5 km far from site one and was composed by two finishing units (700 animals/unit). Nursery (in site one) was managed all-in-all-out (AIAO) by room (without mixing animals of different ages) whereas site two was managed in continuous flow. The tested farm was 2.5 km away from the nearest pig farm. This herd was conveniently selected mainly due to the willingness of the producer and the practitioner to participate in the project and the previous evidence of PCV2 infection. The farm used a self-replacement (sows) strategy and at the moment of the study there were 2 boars in the farm. No animals (sows or boars) coming from outside sources entered into the facilities during the study.

Before starting mass vaccination strategy, a PCV2 vaccination program was already in place: sows were vaccinated twice with 2 ml of an inactivated vaccine (Circovac®, Merial) (at 6 and 3 weeks before farrowing) at the first gestation cycle and once (at 3 weeks before farrowing) in the following cycles. Piglets were vaccinated off-label (0.5 ml/piglet) at 3 weeks of age with a subunit vaccine (Ingelvac Circoflex®, Boehringer Ingelheim).

2.2. Study design

Study design is summarized in Table 1. The initial PCV2 infection and serological status of the farm was assessed by PCR and ELISA, respectively, on serum samples of pigs and sows in two consecutive months before starting (December 2010 and January 2011) the mass vaccination program (February 2011 to January 2012). These two months prior the mass vaccination strategy was named as the "PRE" period for the purpose of the study. The mass vaccination strategy consisted of the vaccination of all sows, boars and gilts of the farm with 1 ml of Ingelvac Circoflex® every four months (3 doses/animal/year) in a blanket fashion (all animals were vaccinated at the same day, irrespectively of their physiological status). In addition, all piglets were vaccinated with 1 ml of the same vaccine at 4 and 7 weeks of age. The first-dose of piglet PCV2 vaccine was administrated later than the usually recommended age (3 weeks) to avoid a putative interference of maternal immunity resulting from vaccinated sows (Fort et al., 2009; Fraile et al., 2012a,b). This strategy was applied during 12 consecutive months (from February 2011 to January 2012). This 12-month period was named as the "DURING" period for the purpose of the study. To evaluate whether the eradication of PCV2 infection by mass vaccination was successful, the program was stopped after 12 months (February 2012). Subsequently, piglets and sows from the six following monthly batches were followed up (July 2012). This six month period was named as the "POST" period.

During the study period (2 + 12 + 6 months), blood samples from 15 (5 gilts, 5 from 2nd to 5th parity and 5 older than 5th parity, respectively) sows and from 90 piglets (15 of each age-group; 4, 8, 12, 16, 20 and in some cases at 24 weeks of age) were taken monthly (during the third week of each month). This study design implied that samples from the same animal were taken longitudinally at 4, 8, 12, 16, 20 and 24 weeks of age. Farm boars ($n = 2$) were not monitored in the present study.

Once in the laboratory, blood samples were allowed to clot and were centrifuged at 3400 rpm for 10 min at 4 °C. All samples were frozen at −80 °C until testing.

Animal care and study procedures were conducted in accordance with the guidelines of Good Experimental Practice, under the approval of the Ethical and Animal